Data Quality Objectives for Great Salt Lake Project 3: Measurement and Modeling of Selenium Loads to Great Salt Lake

Step	DQO Guidance of Purpose and Outputs of Step	Great Salt Lake Project
1. Problem Statement	**Purpose:** Clearly define the problem that requires new environmental data so that the focus of the study will be clear and unambiguous. **Outputs From This Step** • A concise description of the problem. • A list of the planning team members and identification of the decision maker. • A summary of available resources and relevant deadlines for the study.	**Problem:** One of the steps required to establish a site-specific standard for selenium in the open waters of GSL is to determine the amount of selenium entering the open water of GSL through surface water, ground water, and atmospheric deposition. With respect to surface water, most rivers that flow into GSL are monitored with respect to discharge and concentration of chemical constituents by the U.S. Geological Survey. Unfortunately, all of the established gaging sites are located significant distances upstream of where the outflow actually enters the open water of GSL. Significant changes in the selenium concentration, as well as other chemical constituents, can occur between the established gaging stations and where the inflow enters into the open water of GSL. New stream gaging station locations are needed that facilitate the measurement of selenium loads entering the open water of GSL. Data gathered from the new gaging infrastructure will allow for the modeling of mean daily selenium loads from all input sources to GSL. The modeling results will be used to determine an annual selenium budget for the open water of GSL. In addition, the modeling results will allow for a comparison of the seasonal and geographic variations in selenium loadings with respect to seasonal biological cycles in the GSL ecosystem (projects 1 and 2). Results from this project will measure the following selenium fluxes identified in the conceptual model: 27 to 33, 68 to 74, and 77. Selenium loadings to the open water of GSL via ground-water discharge and atmospheric deposition are assumed to be small and will not be measured. An ongoing study by researchers at the Duke University is attempting to quantify ground-water discharge to GSL. If successful, their results will be used for the ground-water loading component. **Planning team members:** Dr. David Naftz and Dr. William Johnson (Principal Investigators), and Dr. Earl Byron (Project Advisor), with ultimate decision authority by Utah Department of Environmental Quality, considering input by the GSL Steering Committee and GSL Science Panel. **Resources:** Estimated budget for sampling years 2006-8 is $302,600, including USGS cost-sharing ($89,000) and lab costs. Equipment needed for stream gage installation available through USGS Hydrologic Instrumentation Facility in Mississippi. Trained hydrologic technicians are available among current staff at the USGS Utah Water Science Center for gage installation, operation, and water-quality sampling. Sampling equipment, vehicles, and laboratory trailers used for sampling and sample processing are available from current equipment resources at the USGS Utah Water Science Center in Salt Lake City. Modeling software (LOADEST) and personnel trained in its application are available from current staff at the USGS Water Science Center in Salt Lake City. Finally, the database infrastructure for reporting real-time discharge from the gage sites is operating and available, as are the technical staff and database software (NWIS) for data input and QA/QC of discharge and water-quality data collected from each site. **Deadlines:** Stream gages installed and operating **within 3 weeks of a signed joint funding agreement (on or about** April 15, 2006)**.** Preliminary selenium load estimate due on February 28, 2007. Final selenium loading model and associated report due on July 15, 2008.

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2. Decision Statements	**Purpose**: Define the decision(s) that will be resolved using data to address the problem. **Approach**: Identify the key question that the study attempts to address and alternative actions that may be taken, depending on the answer to the key study question. **Outputs From This Step** • A statement of the decision that must be resolved using data in order to address or solve the problem. • A list of possible actions or outcomes that would result from each resolution of the decision statement. *Note from EPA guidance on DQO: If the principal study question is not obvious and specific alternative actions cannot be identified, then the study may fall in the category of exploratory research, in which case this particular step of the DQO Process may not be needed.*	**Decisions:** A specific decision will not be made with the selenium loading data; however, these data will be used in the overall decision of determining a scientifically defensible selenium standard for the open water of GSL. **Possible outcomes:** 1. Variability in current selenium loadings to GSL has no measurable impact on selenium concentrations in the open-water GSL ecosystem (including food organisms for birds). Future selenium loadings to GSL can be increased concurrent with low intensity water-quality and biological monitoring. 2. Variability in current selenium loadings to GSL has a measurable impact on selenium concentrations in the open-water GSL ecosystem (including food-web organisms). Steps must be taken to reduce present and future selenium loadings (as appropriate, based on other results associated with the lake-wide selenium budget).
3. Inputs to the Decision	**Purpose**: The purpose of this step is to identify the informational inputs that will be required to resolve the decision, and to determine which inputs require environmental measurements. **Activities** • Identify the information that will be required to resolve the decision. • Determine the sources for each item of information identified. • Identify the information that is needed to establish the action level for the study. • Confirm that appropriate field sampling techniques and analytical methods exist to provide the necessary data. **Outputs From This Step** • A list of informational inputs (including sources and potential action levels) needed to resolve the decision. • The list of environmental variables or characteristics that will be measured.	**Informational inputs:** Annual, seasonal, and mean daily selenium loadings contributed to the open-water of GSL from surface water inflows. Inflows to be considered include North Arm inflow (2 culverts and 1 causeway breach, Bear River, Farmington Bay, Weber River, Goggin Drain, Lee Creek, and KUCC outfall. **Variables/characteristics to be measured:** Stream stage at 15-minute intervals using automated equipment. Dissolved and total selenium concentration on monthly to daily intervals depending on stream hydrograph and gage site. Selected samples will be analyzed for selenium species (selenate, selenite, and organic selenium). Field pH, specific conductance, and water temperature during selenium sample collection. At 4- to 6-week intervals, measurement of stream discharge and development of stage/discharge relationship. At gages with hydroacoustic equipment, stream discharge will be measured at a similar time interval using acoustic doppler profiling equipment that will be used to develop and index velocity rating curve.

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4. Study Boundaries	**Purpose**: Specify the spatial and temporal circumstances that are covered by the decision. **Activities** • Define the domain or geographic area within which all decisions must apply. • Specify the characteristics that define the population of interest. • When appropriate, divide the population into strata that have relatively homogeneous characteristics. • Define the scale of decision making. • Determine when to collect data. • Determine the time frame to which the study data apply. • Identify any practical constraints on data collection. **Outputs From This Step** • Characteristics that define the domain of the study. • A detailed description of the spatial and temporal boundaries of the decision. • A list of any practical constraints that may interfere with the study.	**Spatial:** All major surface-water inflow sources to the open water of GSL (south arm) will be gauged and sampled. These sites will include KUCC outfall, N. Arm culverts (2), N. Arm causeway breach, Bear River, Weber River, Farmington Bay, Lee Creek, and Goggin Drain. **Temporal:** The period of data collection will be from on or about April 15, 2006 through February 28, 2008. Stage elevation (converted to discharge) will be collected every 15 minutes using automated equipment. Data packages of discharge and stream stage will be uploaded to the USGS real-time web page via satellite at 4-hour intervals. Discharge measurements by trained technical staff will occur at approximately 6-week intervals at each gage site. After QA/QC, discharge data (mean daily values) will be entered into the USGS National Water Information System and published in the USGS Annual Data Report for the state of Utah, by water year (October 1 thru September 30). Water-quality data (dissolved and total selenium, specific conductance, water temperature, and pH) will be collected on a monthly basis during gage operation. Increased sample frequency will occur during spring runoff and in conjunction with biological sampling frequencies. Selected samples (approximately 4 times per year) will be analyzed for the selenium species of selenite, selenate, and organic selenium for forensic information on selenium sources to GSL. **Practical constraints on data collection:** Continuous discharge records can be impacted by equipment malfunction and natural conditions. Because of the near real-time data streams from each gage site, equipment malfunctions are usually repaired within 48 hours of breakdown. Hazardous conditions such as floods and storms can delay or limit the collection of water quality and discharge data due to safety concerns. Discharge equipment installed at the Bear River and Farmington Bay sites is removed annually from December thru mid-February because of the potential damage to equipment from ice flows.
5. Decision Rules	**Purpose**: The purpose of this step is to integrate the outputs from previous steps into a single statement that describes the logical basis for choosing among alternative actions. **Activities** • Specify the parameter that characterizes the population of interest. • Specify the action level for the study. • Combine the outputs of the previous DQO steps into an "if...then..." decision rule that defines the conditions that would cause the decision maker to choose among alternative actions. **Outputs From This Step** • An "if...then..." statement that defines the conditions that would cause the decision maker to choose among alternative courses of action.	If the annual, seasonal, and/or daily selenium loads to the open water of GSL measured during the study period appear to cause associated changes in the lake's selenium concentrations and result in biological effects, then action should be taken to reduce selenium loads in the GSL watershed (as indicated by studies of sediment storage and other aspects of the lake-wide selenium budget). If the annual, seasonal, and/or daily selenium loads to the open water of GSL measured during the study period result in no associated changes in the lake's selenium concentrations or measurable biological effects, then consideration should be given to allowing an increase in selenium loads to GSL. If increased selenium loads are permitted, low-intensity hydrologic and biological monitoring should be executed.

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6. Tolerable Limits on Decision Rules	**Purpose**: Specify the decision maker's acceptable limits on decision errors, which are used to establish appropriate performance goals for limiting uncertainty in the data. **Activities** • Determine the possible range of the parameter of interest. • Define both types of decision errors and identify the potential consequences of each. • Specify a range of possible parameter values where the consequences of decision errors are relatively minor (gray region). • Assign probability values to points above and below the action level that reflect the acceptable possibility for the occurrence of decision errors. • Check the limits on decision errors to ensure that they accurately reflect the decision maker's concern about the relative consequences for each type of decision error. **Outputs From This Step** • The decision maker's acceptable decision error rates based on a consideration of the consequences of making an incorrect decision.	Measured parameters that will impact the decision errors will include stream stage, stream discharge, and selenium concentration (total, dissolved, and selenium species). Measurement error for stream stage and discharge are generally +/- 10 percent; however, certain conditions such as loss of record from equipment malfunction can increase the error range for short time periods. Missing records are qualified in the data base and subsequent selenium loading values calculated with estimated records are also qualified. With the exception of selenium species, measurement error for the analysis of selenium is generally between +/- 5 to 10 percent. Because of the experimental nature of selenium species determination, the analytical error may exceed +/- 20 percent. Sampling error will be minimized by stringent equipment cleaning procedures and sampling methods that integrate samples from the entire stream cross section in equal discharge increments. Policy decisions will be primarily based on dissolved and total selenium loadings; the overall error in discharge measurement and selenium analysis of +/- 10 percent will be within acceptable limits for arriving at accurate and defensible decisions.
7. Optimization of the Sampling Design	**Purpose**: Identify the most resource-effective sampling and analysis design for generating data that are expected to satisfy the DQOs. **Activities** • Review the DQO outputs and existing environmental data. • Translate the information from the DQOs into a statistical hypothesis. • Develop general sampling and analysis design alternatives. • For each design alternative, formulate the mathematical expressions needed to solve the design problems. • For each design alternative, select the optimal sample size that satisfies the DQOs. • Select the most resource-effective design that satisfies all of the DQOs. • Document the operational details and theoretical assumptions of the selected design in the Sampling and Analysis Plan. **Outputs From This Step** • The most resource-effective design for the study that is expected to achieve the DQOs, selected from a group of alternative designs generated during this step.	After detailed consideration of reasonable alternatives, the following design is the most resource effective: 1. Utilize trained USGS stream gaging technicians that are locally available for gage installation, gage servicing, and sample collection. 2. Utilize established USGS methods, discharge equipment, and software for gage operation, data transmission, and data archiving. 3. Utilize existing and local sampling infrastructure (sampling equipment, sampling protocol, vehicles, and laboratory trailers) to execute the sampling plan. 4. Utilize existing technical, database, and publication resources for data QA/QC, real-time data transmission, data archiving, and publication and distribution of results to all interested parties.